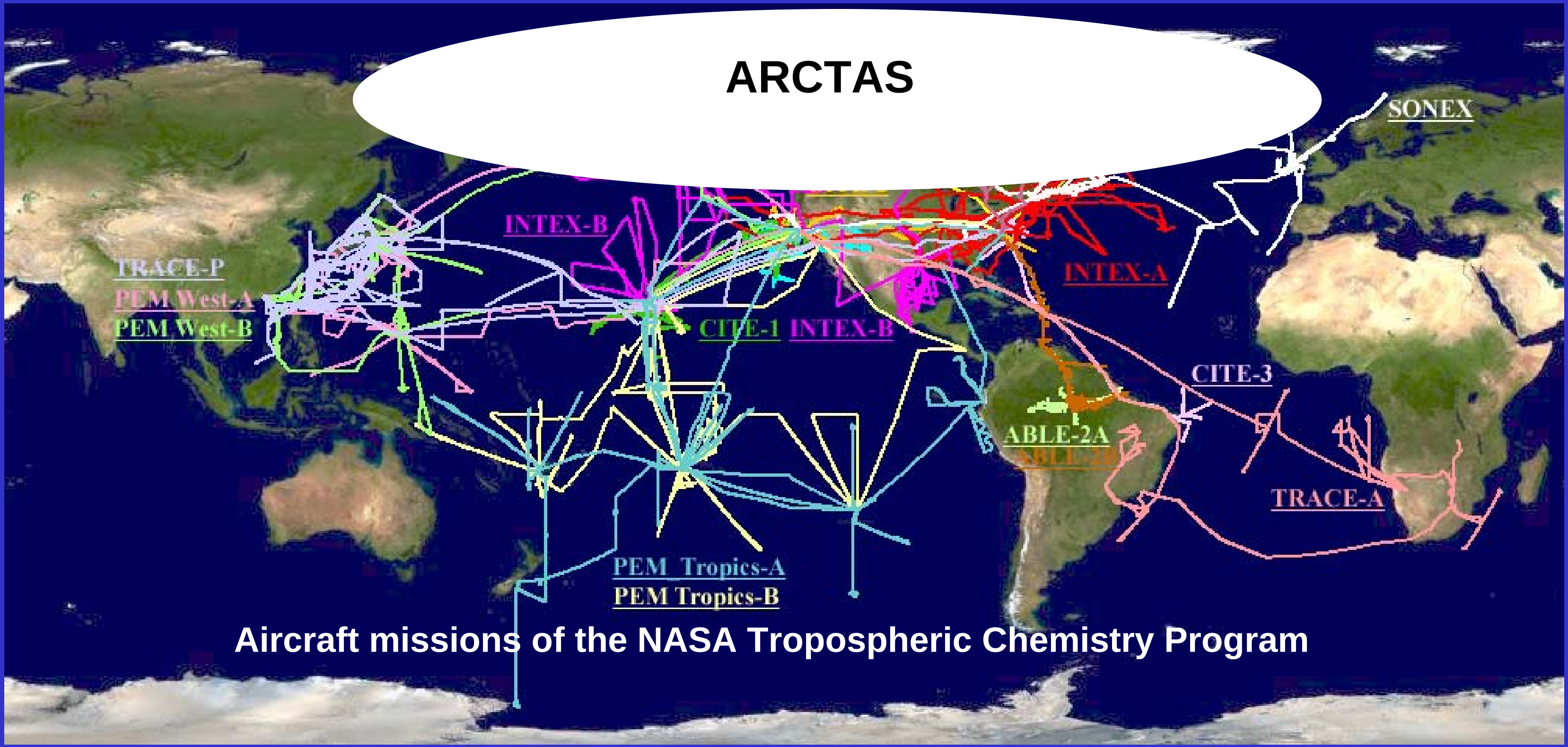
AURA VALIDATION DURING THE ARCTAS AIRCRAFT MISSION

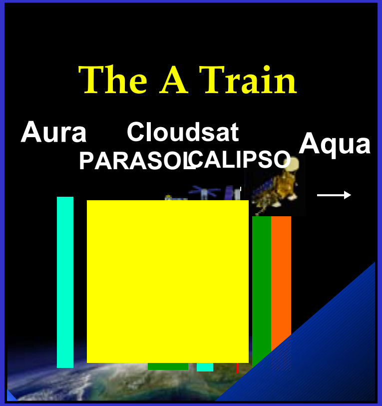
Daniel J. Jacob, Harvard University



- Two 3-week deployments: April 2008 (Fairbanks/Thule), July 2008 (Edmonton)

- Three NASA aircraft: DC-8 (in situ chemistry and aerosols), P-3B (radiation and in situ aerosols), B-200 (aerosol remote sensing and CALIPSO validation)

URGENT NEED TO BETTER UNDERSTAND ARCTIC ATMOSPHERIC COMPOSITION AND CLIMATE



ARCTIC IS A BEACON OF GLOBAL CHANGE

- Rapid warming over past decades
- Receptor of mid-latitudes pollution – arctic haze, ozone build-up, accumulation of persistent pollutants
- Large and increasing influence from boreal forest fires in Siberia and North America

POTENTIALLY LARGE RESPONSE

- Melting of polar ice sheets and permafrost
- Decrease of snow albedo from soot depostion
- Efficient UV/Vis absorption by ozone, soot
- Halogen radical chemistry

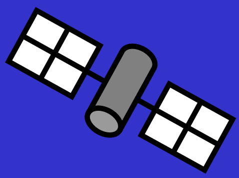
UNIQUE OPPORTUNITY FOR NASA

- Large NASA satellite fleet for atmospheric composition and radiation
- Interagency and international collaboration through POLARCAT international atmospheric chemistry field program during IPY
- Broader synergies enabled by other IPY activities (OASIS for oceans, etc.)

ARCTAS STRATEGY: use aircraft to increase value of satellite data for models of arctic atmospheric composition and climate

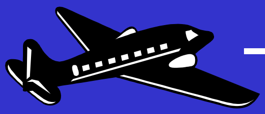
Satellite instruments: CALIPSO, OMI, TES, HIRDLS, MLS, MODIS, AIRS, MISR, MOPITT

- Aerosol optical depth, properties
- CO, ozone, BrO, NO_2, HCHO



Aircraft: DC-8, P-3B, B200

- Detailed in situ chemical and aerosol measurements
- Remote sensing of ozone, aerosol, surface properties



- Retrieval development & validation
- Observational error characterization
- Correlative information
- Local chemical & aerosol processes

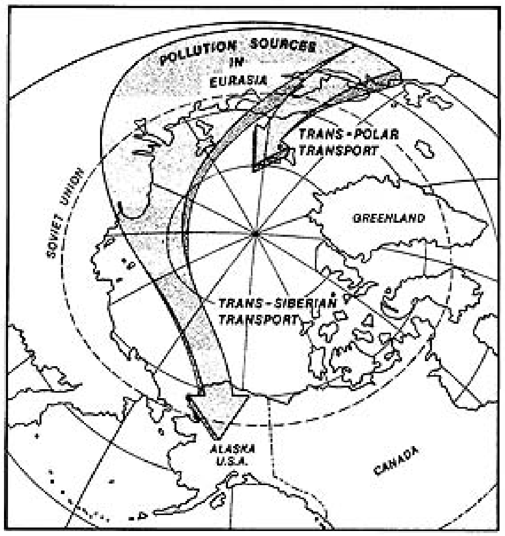
Data assimilation
Diagnostic studies

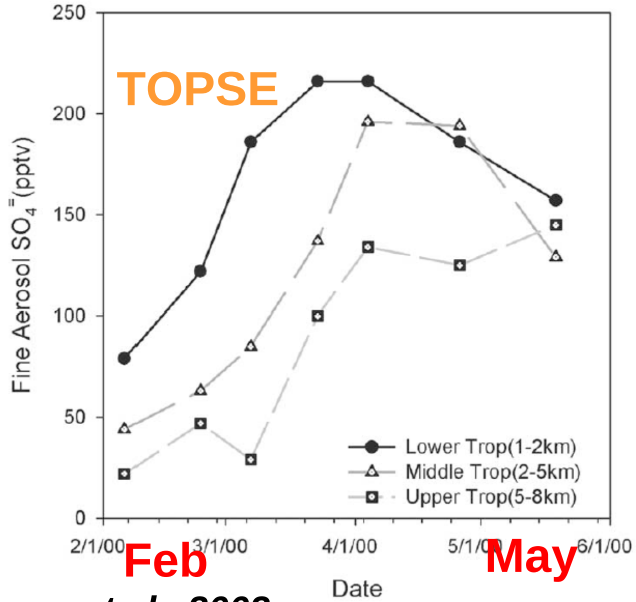
Models: CTMs, GCMs, ESMs

- Source-receptor relationships for Arctic pollution
- Effects of boreal forest fires
- Aerosol radiative forcing
- Arctic chemistry

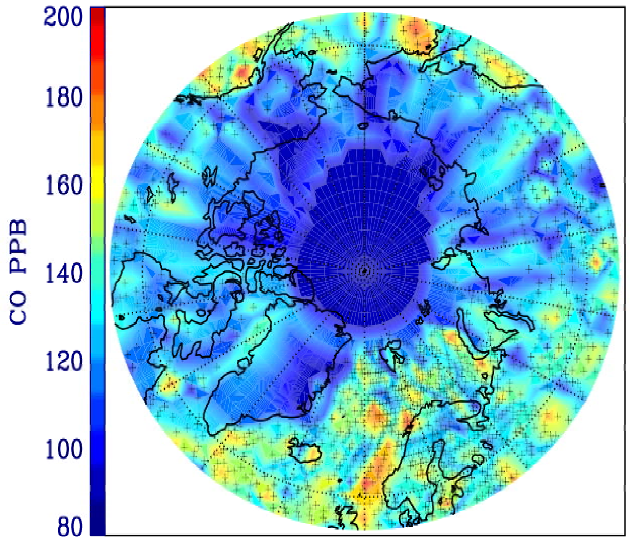
ARCTAS Science Theme 1:
Transport of mid-latitudes pollution to the Arctic

European influence | **Seasonal sulfate build-up** | **TES 600 hPa CO, March 2006**





Scheuer et al., 2003



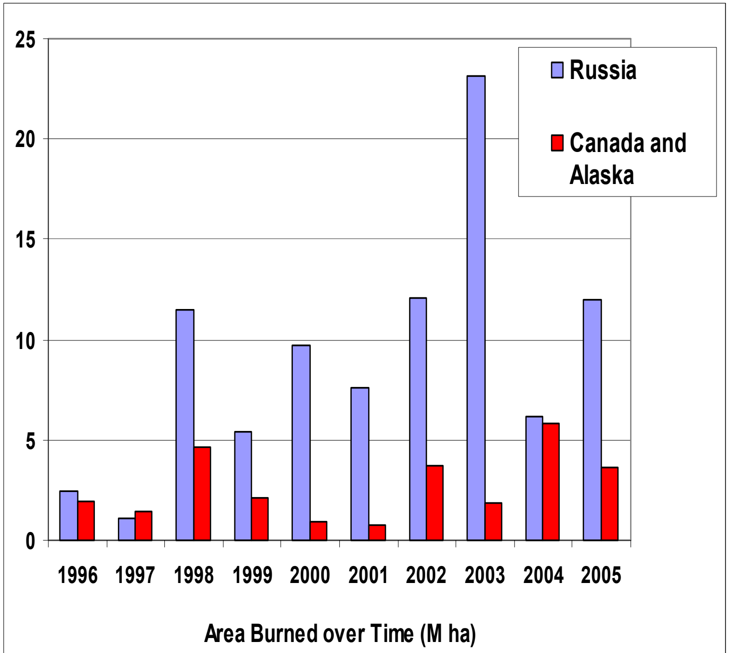
J. Worden, JPL

- What are the transport pathways for different pollutants?
- What are the contributions from different source regions, what are the source-receptor relationships?

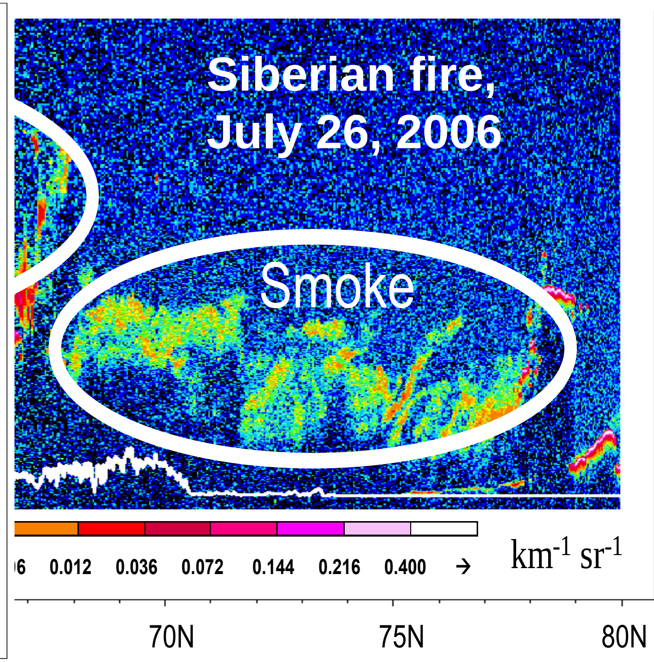
Satellite capabilities:
- CO (TES, AIRS, MOPITT)
- Ozone (TES, OMI-MLS)
- aerosols (CALIPSO, MODIS, MISR)

Aircraft added value:
- detailed chemical composition
- tracers of sources
- vertical information

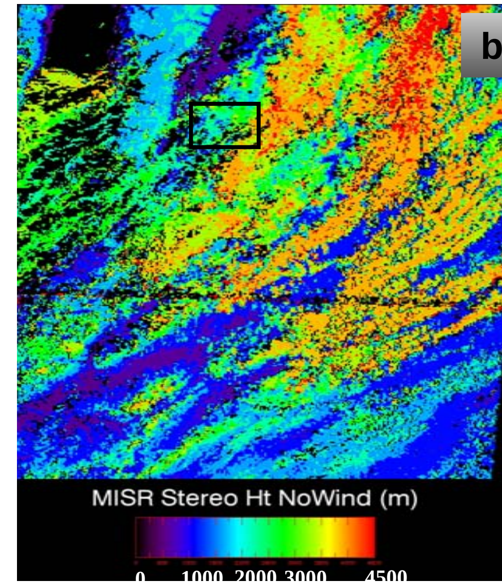
ARCTAS Science Theme 2: Boreal forest fires



A. Soja, LaRC



C. Trepte, LaRC



R. Kahn, JPL

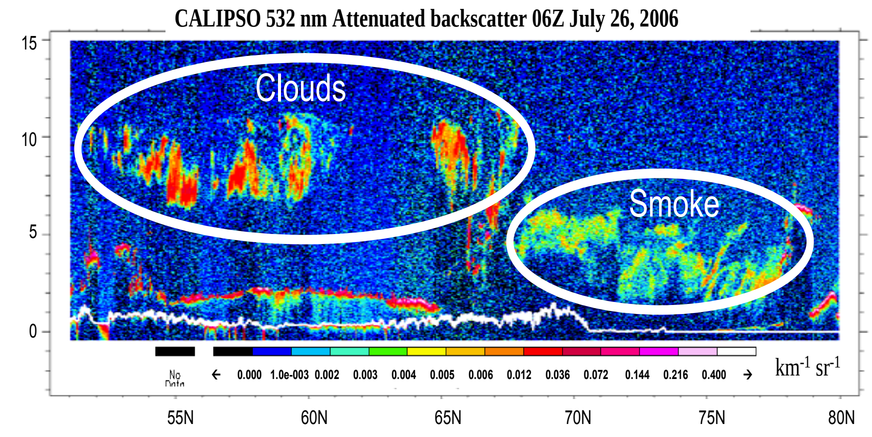
- What is the chemical composition & evolution of the fire plumes?
- What are their aerosol optical properties, how do these evolve?
- What are the injection heights, what are the implications for transport & chemistry?

Satellite capabilities:
- aerosols (CALIPSO, MODIS, MISR, OMI)
- CO (TES, AIRS, MOPITT, MLS)
- Ozone (TES, OMI-MLS)

Aircraft added value:
- detailed chemical composition
- aerosol properties
- pyroconvective outflow

ARCTIC Science Theme 3: Aerosol radiative forcing

CALIPSO clouds and smoke **Arctic haze** **MISR true-color fire plume**



C. Trepte, LaRC

R. Kahn, JPL

- What is the regional radiative forcing from Arctic haze, fire plumes?
- How does this forcing evolve during plume aging?
- What are the major sources of soot to the Arctic?
- What is the effect of deposited soot on ice albedo?

Satellite capabilities:

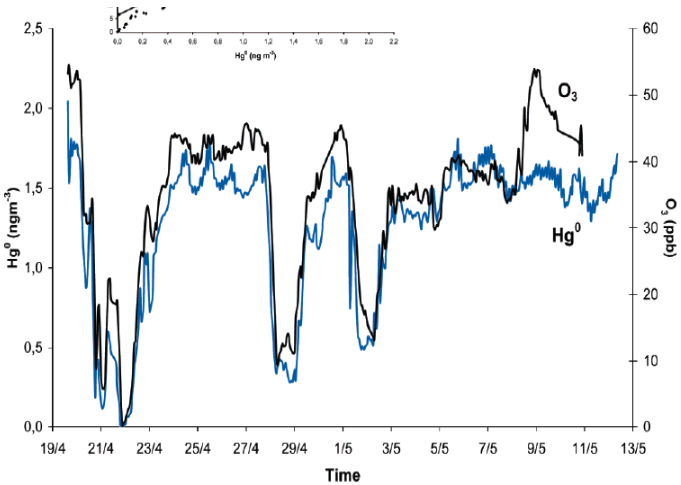
- UV/Vis/IR reflectances (Cloudsat, MODIS, MISR, OMI)
- multi-angle sensing (MISR)
- lidar (CALIPSO)

Aircraft added value:

- detailed in situ aerosol characterization
- remote sensing of radiances, fluxes
- BRDF of surface

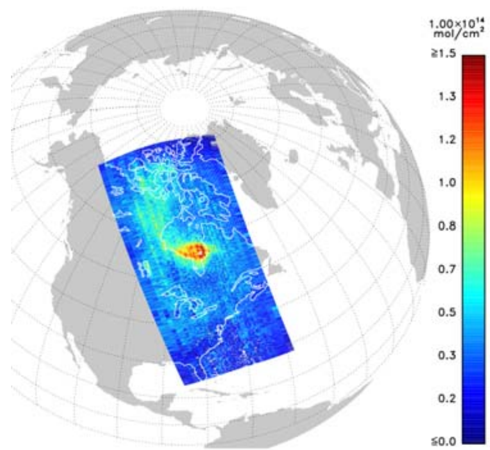
ARCTAS Science Theme 4: Chemical processes

Ozone, Hg depletion events



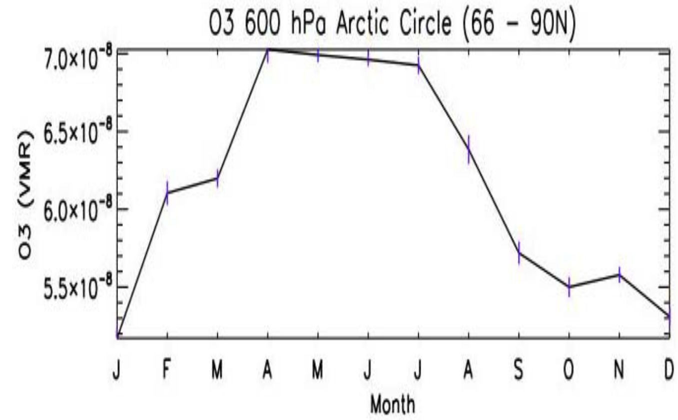
Sprovieri et al. [2005]

OMI tropospheric BrO



K. Chance, Harvard/SAO

TES tropospheric ozone



J. Worden, JPL

- What is the HO_x/NO_x chemistry in the Arctic?
- What drives halogen radical chemistry in the Arctic, what is its regional extent?
- What are the regional implications of halogen chemistry for ozone and mercury?
- How does stratosphere-troposphere exchange affect tropospheric ozone in the Arctic?

Satellite capabilities:

- Ozone (TES, OMI/MLS)
- BrO (OMI)
- strat-trop exchange (HIRDLS)
- CO (TES, AIRS, MOPITT)

Aircraft added value:

- detailed chemical characterization, constraints on photochemical models
- validation of OMI tropospheric BrO
- HO_x measurement intercomparison

AIRCRAFT PLATFORMS, PAYLOADS

DC-8: in situ chemistry and aerosols

Ceiling 37 kft, range 4000 nmi, endurance 9 h

Payload: O_3, H_2O, CO, CO_2, CH_4, NO_x and HO_x chemistry, BrO, mercury, NMVOCs, halocarbons, SO_2. HCN/CH_3CN, actinic fluxes, aerosol composition, aerosol mass and number concentrations, aerosol physical and optical properties, remote ozone and aerosol

P-3B: radiation and in situ aerosols

Ceiling 30 kft, range 3800 nmi, endurance 8 h

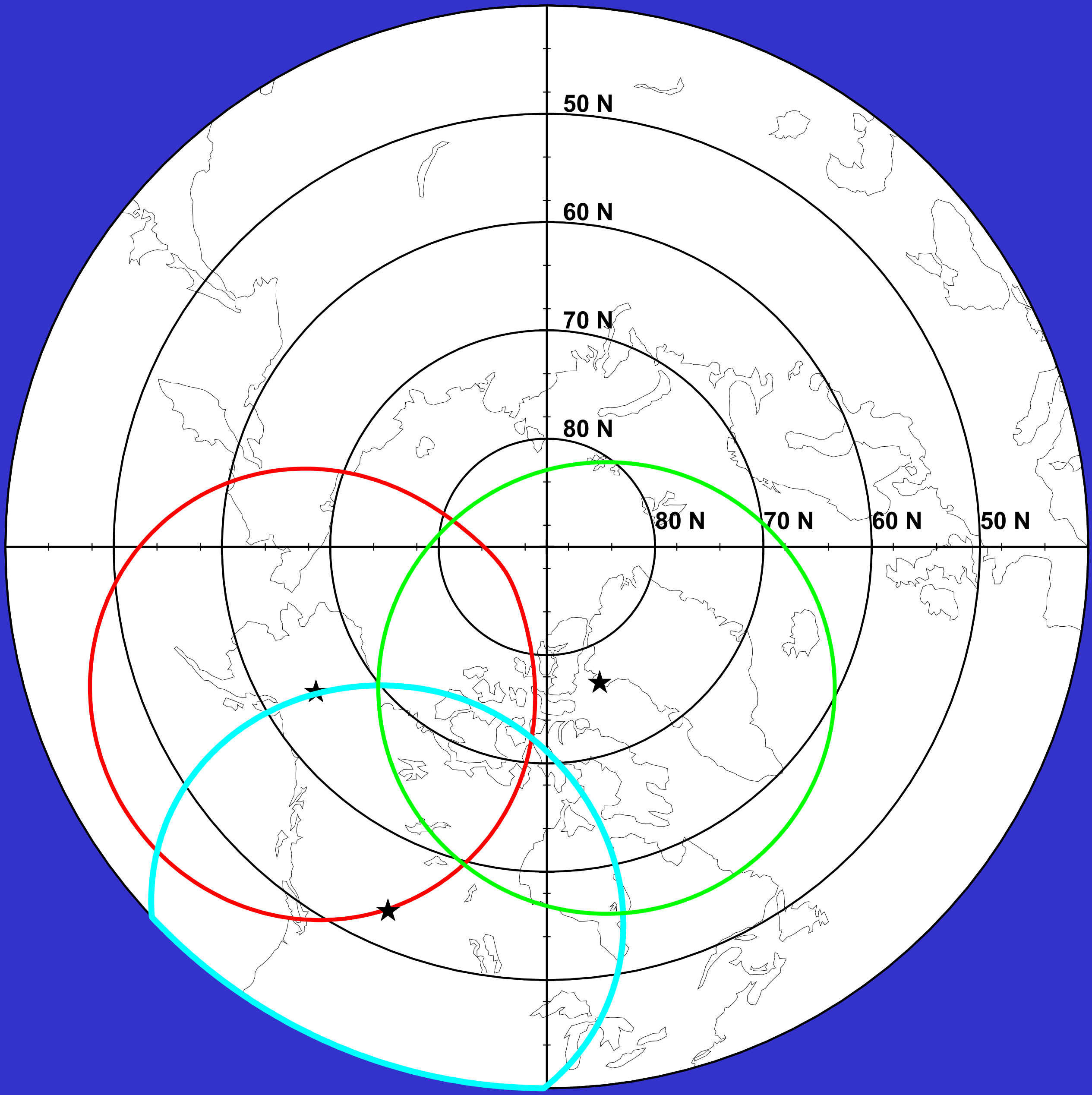
Payload: optical depth, radiative flux, radiance spectra, aerosol composition, black carbon

B-200: aerosol remote sensing and CALIPSO validation

Ceiling 32 kft, range 800 nmi, endurance 3.5 h

Payload: High Spectral Resolution Lidar (HSRL)
Research Scanning Polarimeter (RSP)

ARCTAS BASES AND NOMINAL DC-8/P-3 RANGES



Spring:
Fairbanks
Thule (suitcase)

Summer:
Edmonton

HOW CAN ARCTAS BEST SERVE AURA VALIDATION NEEDS IN THE ARCTIC IN THE CONTEXT OF ARCTAS SCIENTIFIC GOALS?

- **April deployment:**
  - Identified priority: OMI BrO validation
  - What other useful tropospheric information can we expect from Aura in April over the Arctic? Ozone columns? Ozone structure at tropopause? CO pollution plumes?
  - What environments/surfaces provide the best/worst opportunities for satellite observation? Which are most important for validation?
  - Is there a big seasonal transition in Aura viewing capabilities over the course of April? Is late April much better than early April?
  - Can ARCTAS enable not just the validation but also the development of retrieval algorithms?
- **July deployment:**
  - Identified priority: Ozone-CO-NO_2-HCHO-aerosols validation in forest fire plumes
  - Also TES methane (Greg Osterman presentation)
  - Are there other validation needs beyond what has been done before? Are there important new environments/conditions to validate? Does concern over instrument drift justify a repeat of past validation?